

Final Report

Arizona Grain Research and Promotion Council

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Crop Coefficients for Estimating Small Grain Water Use

Mike Ottman
University of Arizona

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M. J. Ottman

Summary

Crop coefficients are used to estimate water use from reference evapotranspiration values provided by weather stations. Two varieties of barley and durum were planted at the Maricopa Agricultural Center in late November and early January. Water use was estimated from neutron probe readings and crop coefficients were calculated by dividing water use by reference evapotranspiration. The crop coefficients calculated in this study peaked at 1.0 or less in contrast to published values which generally peak around 1.2. The crop coefficients were lower at the later planting, and there appear to be differences between barley and durum and among barley varieties.

Introduction

Crop coefficients are used to calculate water use from weather data. The crop coefficient increases as the crop develops, reaches a peak, and then decreases as the crop senesces. Crop coefficients are most accurate if locally developed using current cropping practices. Crop coefficients have not been developed for Arizona, and we currently rely on values from California or values estimated indirectly from water use work done on outdated varieties by the Water Conservation Research Laboratory in Phoenix in the 1950's and 1960's. We intend to use the crop coefficients developed in Arizona to provide water use estimates for the Small Grain Advisory and for AZSCHED, irrigation scheduling software for Arizona. The purpose of this study is to develop crop coefficients for wheat and barley in Arizona.

Procedures

Two durum varieties (Kronos and WPB 881) and two barley varieties (Barcott and Baretta) were planted at two dates (Nov 26, 2002 and Jan 3, 2003) at the Maricopa Agricultural Center. The plots were 42 ft by 40 ft in size and replicated twice in a randomized complete block design. Preplant fertilizer included 48 lbs N/acre and 60 lbs P₂O₅/acre as 16-20-0. Irrigation was applied at about 50% depletion of plant available water and 248 to 270 pounds of N were applied per acre (Table 1). Water use was estimated in 1 ft depth increments to 4 ft from weekly neutron probe readings. Crop coefficients were calculated by dividing water use by reference evapotranspiration (ET_o, original AZMET calculation method) from AZMET. The crop coefficients are paired with the respective heat units after planting for barley and wheat.

Results and Discussion

The average maximum temperature for January was the highest on record, and the average minimum temperature for January was also very high (Table 2). Consequently, the crop grew very quickly early in the season, especially the barley. March and April were cooler than average, which promoted a long growing season. Every month of the growing season from December through May received below average rainfall except for February, where rainfall was slightly above average. The weather was very favorable for growth of wheat and barley.

Published values of crop coefficients for barley and wheat peak around 1.2, whereas the values obtained this year peak near 1.0 or less (Table 3). The crop coefficients were lower at the later planting date, and there appear to be differences between durum and barley and among barley varieties.

Acknowledgements

The technical assistance of Melinda Main is greatly appreciated.

Table 1. Cultural practices for the small grains planted on November 26, 2002 and January 3, 2003.

Cultural practice	November 26, 2002 planting	January 3, 2003 planting
Field	107	107
Border	4 (from south)	2 (from south)
Previous crop	Barley	Barley
Preplant soil NO ₃ -N	18.8 ppm	18.8 ppm
Preplant soil P	6.6 ppm	6.6 ppm
Row spacing	7 inches	7 inches
Barley seeding rate	80 lbs/acre	80 lbs/acre
Durum seeding rate	100 lbs/acre	100 lbs/acre
Irrigation and fertilization	11/26 + 48 lbs N/a and 60 lbs P ₂ O ₅ /a	
	01/29 + 72 lbs N/a	01/03 + 48 lbs N/a and 60 lbs P ₂ O ₅ /a
	02/27 + 50 lbs N/a	02/27 + 50 lbs N/a
	03/19 + 50 lbs N/a	03/19 + 50 lbs N/a
	04/01 + 50 lbs N/a	04/01 + 50 lbs N/a
	04/11	04/11 + 50 lbs N/a
	04/25	04/25
		05/09
Total N applied	270 lbs N/a	248 lbs N/a

Table 2. Climatic data for Maricopa during the 2003 growing season compared to the long-term average. The rankings of the months in the 18 years of data are from low to high. The climate data was obtained from AZMET.

Climate variable	Unit	Year(s)	Dec	Jan	Feb	Mar	Apr	May	Dec-May
Max Temp. (°F)	Rank of 18	2003	6	18	6	6	4	13	11
	°F	2003	64	73	68	76	82	95	76
	°F	1987-2003	65	66	70	76	85	94	76
Min Temp. (°F)	Rank of 18	2003	14	16	14	6	4	12	14
	°F	2003	37	39	42	43	48	60	45
	°F	1987-2003	35	36	40	44	51	59	44
Ppt. (inches)	Rank of 18	2003	10	9	12	7	9	1	10
	inches	2003	0.43	0.51	1.18	0.24	0.16	0	2.52
	inches	1987-2003	0.82	0.79	0.97	0.94	0.33	0.18	3.98

Table 3. Crop coefficients calculated for various growth periods for the two plantings matched with heat units. The heat units are cumulative growing degree days since planting with base and ceiling temperatures of 32 and 95°F.

Planting date	Growth period	Heat units	Barcott	Baretta	Kronos	WB881	Barley	Wheat	All
Nov 26	12/18 - 12/26	535	0.049	0.225	0.011	-0.032	0.137	-0.010	0.063
	12/26 - 01/03	653	0.222	0.138	0.127	0.135	0.180	0.131	0.156
	01/03 - 01/13	847	0.487	0.438	0.305	0.269	0.462	0.287	0.375
	01/13 - 01/21	1057	0.546	0.621	0.467	0.517	0.583	0.492	0.538
	01/21 - 01/28	1240	0.756	0.474	0.647	0.558	0.615	0.603	0.609
	02/04 - 02/12	1580	0.681	0.695	0.620	0.653	0.688	0.636	0.662
	02/18 - 02/26	1920	0.880	0.790	0.813	0.796	0.835	0.804	0.820
	03/05 - 03/13	2257	0.845	0.879	0.680	0.788	0.862	0.734	0.798
	03/13 - 03/18	2461	0.921	1.125	0.891	0.901	1.023	0.896	0.959
	03/24 - 04/01	2827	0.941	1.001	0.835	0.888	0.971	0.861	0.916
	04/05 - 04/11	3137	0.628	0.878	0.680	0.688	0.753	0.684	0.718
	04/16 - 04/24	3544	0.486	0.808	0.642	0.698	0.647	0.670	0.658
	04/30 - 05/07	4026	0.438	0.713	0.819	0.948	0.576	0.883	0.730
	05/07 - 05/14	4280	0.404	0.542	0.506	0.573	0.473	0.540	0.506
	05/14 - 05/21	4582	0.399	0.34	0.113	0.151	0.369	0.132	0.251
	05/21 - 05/30	4996	0.283	0.182	0.014	0.017	0.232	0.015	0.124
Jan 03	01/30 - 02/06	739	0.182	0.247	0.167	0.208	0.215	0.188	0.201
	02/06 - 02/12	856	0.344	0.193	0.200	0.225	0.269	0.212	0.240
	03/07 - 03/14	1559	0.571	0.648	0.553	0.612	0.610	0.583	0.596
	03/24 - 04/01	2085	0.578	0.672	0.587	0.647	0.625	0.617	0.621
	04/16 - 04/24	2802	0.839	0.896	0.680	0.688	0.867	0.684	0.776
	04/30 - 05/09	3322	0.561	0.753	0.588	0.596	0.657	0.592	0.625
	05/14 - 05/21	3840	0.312	0.520	0.174	0.301	0.416	0.237	0.327

	05/21 - 05/30	4254	0.352	0.138	0.065	0.161	0.245	0.113	0.179
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